FORM PTO-1390 (REV 10-2000)

U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: WLL-12659

US APPLICATION NO (If known, see 37 CFR 1 5): 09/937945

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/CH00/00189	30 March 2000	3 April 1999

TITLE OF INVENTION: DRIVE SYSTEM OPERATED BY MUSCLE-POWER

APPLICANT(S) FOR DO/EO/US: FUCHS, Andreas; BLATTER, Jurg

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. [X] The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:

    Copy of the International Preliminary Examination Report.
    Application Data Sheet.

410 Rec'd PCT/PTO 0 2 OCT 2001

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/937945	PCT/CH00/00189	WLL-12659

17. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1000.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$710.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**

CALCULATIONS PTO USE ONLY		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$	890.00
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	0.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	23 - 20 =	3	X **$18.00**	$	54.00
Independent claims	1 - 3 =	0	X **$80.00**	$	0.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$	0.00
TOTAL OF ABOVE CALCULATIONS =				$	944.00
☑ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$	472.00
SUBTOTAL =				$	472.00
Processing fee of **$130.00** for furnishing the English translation later than ☐20 ☐30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	0.00
TOTAL NATIONAL FEE =				$	472.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	0.00
TOTAL FEES ENCLOSED =				$	472.00
				Amount to be refunded:	$
				charged:	$

a. ☒ A check in the amount of $ 472.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 18-0160 in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 18-0160. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Customer No. 007609
Rankin, Hill, Porter & Clark LLP
700 Huntington Building
925 Euclid Avenue
Cleveland, Ohio 44115-1405

SIGNATURE:

David E. Spaw
NAME

34732
REGISTRATION NUMBER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Andreas Fuchs and Jürg Blatter	
Serial No.:	N/A	Art Unit: N/A
Filing Date:	Herewith	
International Application No.:	PCT/CH00/00189	
International Filing Date:	30 March 2000	
Title:	DRIVE SYSTEM OPERATED BY MUSCLE-POWER	
Examiner:	N/A	
Docket No.:	WLL-12659	

PRELIMINARY AMENDMENT "A"

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend the above-identified application, prior to examination thereof, in the following manner.

Express Mail Label No.: EL517858318US

IN THE CLAIMS:

Please amend the claims as follows:

1. (Amended) An electric drive system operated with muscle-power (1) for a vehicle (2) and/or a stationary training apparatus (3) with a foot pedal (5) and a generator (6) mechanically connected with the foot pedal, with an electric transmission (4) from the generator (6) to an electric consumer (10) and/or to a drive motor (11) as well as with an electric control system (20), wherein the electric control system comprises a control program (21) of the generator (6), with which a counter moment GM on the generator, related to the forwards pedaling direction v is generatable,

wherein the drive system, as a vehicle drive with counter moment, comprises a starting control (22) of the generator, with which, when the foot pedal is actuated from standstill, an immediately occurring pedal resistance TW is generated and with which a high starting moment MA is generated at the foot pedal when starting from standstill up to a minimum riding speed,

and wherein the drive system, as a drive with counter moment for a stationary training apparatus (3), comprises a motor operation control (23) with a bidirectional converter (31), with which the generator (6) is also operatable as a motor, with controllable coupling and uncoupling of electric power.

2. (Amended) The drive system in accordance with claim 1, wherein the standstill pedal resistance TW corresponds to an actuation force F on the foot pedal (5) of at least 200 N.

3. (Amended) The drive system according to claim 1, wherein the starting moment MA at the foot pedal amounts to at least 40 Nm.

4. (Amended) The drive system in accordance with claim 1, wherein the starting

control (22) of the generator is controlled such that the starting acceleration of the foot pedal (bmax) on average amounts to a maximum of 4 rad/sect.

5. (Amended) The drive system according to claim 1, wherein the resistance or load moment (M1) of the generator is modulated in phase with the pedal angle (W1).

6. (Amended) The drive system in accordance with claim 1, wherein a standstill braking (71) of the foot pedal is active, which produces a standstill pedal resistance TW and which is also effective in case the electric control system (20) is switched off.

7. (Amended) The drive system according to claim 1, wherein the generator is short-circuited by means of an electric switch (33) directly or through resistors, capacitors and coils and wherein the electric switch, in case the electric control system (20) is switched off, is closed for the generation of the pedal resistance TW.

8. (Amended) The drive system in accordance with claim 7, wherein, by means of brief switching on and switching off (choppering) of the electric switch (33) during the starting, the high starting moment MA is generated.

9. (Amended) The drive system according to claim 1, wherein a range of the maximum efficiency of the generator (6) corresponds to a normal range of the pedaling frequency, said normal pedaling frequency range being between about 50 - 100 rpm.

10. (Amended) The drive system according to claim 1, wherein the generator control program (21) comprises several moment characteristics (M60, M120), which are able to be changed over between, and which increase within, a normal range of the pedaling frequency.

11. (Amended) The drive system according to claim 1, wherein, to the foot pedal (5) and to the generator (6), electrical, mechanical or fluid brakes (45), such as braking resistors,

eddy current brakes, friction brake pads, gas - and fluid damping elements or mechanical storage devices (46), such as spring-power storage devices or gas - and liquid storage devices are assigned.

12. (Amended) The drive system in accordance with claim 1, wherein a blockable free-wheel system (42) or a switchable clutch (43) is provided between the foot pedal and the generator.

13. (Amended) The drive system according to claim 1, wherein the drive system comprises modular units, said modular units being selected from the group consisting of a pedal generator module (8) with foot pedal (5), generator (6), a possible speed transmission (7) and generator control system (20.1), a control module (20) and a drive motor module (18) with motor (11), a possible speed reduction transmission (12) and a motor control system (20.2).

14. (Amended) The drive system in accordance with claim 1, wherein electric storage devices (14), and in particular a super capacitor (15) (super cap), are provided as short-term storage devices.

15. (Amended) The drive system according to claim 1, wherein two differently designed motors, (11a, 11b) each respectively for higher and a lower speed range, or a motor with switched windings is provided.

16. (Amended) The drive system according to claim 1, wherein operating data, such moments or torques, powers and revolutions per min on the foot pedal are recorded and indicated.

17. (Amended) The drive system according to claim 1, wherein an interface (35) is provided for connecting external devices.

18. (Amended) The drive system in accordance with claim 1, wherein a removable data storage device (29) is provided, which when it is removed carries out a closing function of the system.

19. (Amended) The drive system according to claim 1, wherein the electric circuit comprises operating programs (24), resp., driving riding programs (25) for the utilization in training apparatuses, resp., vehicles.

20. (Amended) The drive system in accordance with claim 1, wherein the electric control system (20) after a selectable time interval, during which no traveling motion takes place, goes over into an inoperative or idle condition and/or the pedal is moved to a desired starting position.

21. (Amended) The drive system according to claim 1, wherein the foot pedal (5) comprises a changeable geometry.

22. (Amended) A vehicle with a drive system in accordance with claim 1.

23. (Amended) A training apparatus with a drive system according to claim 1.

IN THE ABSTRACT:

Please replace the original abstract with the following:

Abstract of the Disclosure

An electric drive system (1) operated by muscle power includes a foot pedal (5) and a mechanical generator (6) mechanically connected to the foot pedal. The drive system also includes an electric transmission (4) and an electric control system (20) with a control program (21) of the generator, which is able to generate a counter or load moment GM. When used in a vehicle (2), the drive system also includes a starting control system (22) for the generator, by means of which a standstill pedal resistance TW and a high starting moment MA is produced at the foot pedal. When used in a stationary training apparatus (3), the drive system includes a motor operation control system (23) with a bi-directional converter (31), by means of which the generator is also able to be operated as a motor.

REMARKS

Attached hereto is a marked-up version of the changes made to the application by the present Amendment. If clarification of the amendment or application is desired, or if issues are present which the Examiner believes may be quickly resolved, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite prosecution of the present application.

If there are any additional fees resulting from this communication, please charge same to our Deposit Account No. 18-0160, our Order No. WLL-12659.

Respectfully submitted,

RANKIN, HILL, PORTER & CLARK LLP

By: _____
David E. Spaw, Reg. No. 34732

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Attachment: Marked-up version of Amendments

IN THE CLAIMS:

The claims have been amended as follows:

1. (Amended) ~~[Electric]~~ An electric drive system operated with muscle-power (1) for a vehicle (2) and/or a stationary training apparatus (3) with a foot pedal (5) and a generator (6) mechanically connected with the foot pedal, with an electric transmission (4) from the generator (6) to an electric consumer (10) and/or to a drive motor (11) as well as with an electric control system (20), ~~[characterised in that]~~ wherein the electric control system comprises a control program (21) of the generator (6), with which a counter moment GM on the generator, related to the forwards ~~[pedalling]~~ pedaling direction v is generatable,

~~[-]~~wherein the drive system, as a vehicle drive with counter moment~~[,]~~, comprises a starting control (22) of the generator, with which, when the foot pedal is actuated from standstill, an immediately occurring pedal resistance TW is generated and with which a high starting moment MA is generated at the foot pedal when starting from standstill up to a minimum riding speed,

~~[-]~~and wherein the drive system, as a drive with counter moment for a stationary training apparatus (3)~~[,]~~, comprises a motor operation control (23) with a bidirectional converter (31), with which the generator (6) is also operatable as a motor, with controllable coupling and uncoupling of electric power.

2. (Amended) ~~[Drive]~~ The drive system in accordance with claim 1, ~~[characterised in that]~~ wherein the standstill pedal resistance TW corresponds to an actuation force F on the foot pedal (5) of at least 200 N.

3. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein the starting moment MA at the foot pedal amounts to at least 40 Nm.

4. (Amended) ~~[Drive]~~ The drive system in accordance with ~~[one of the preceding claims, characterised in that with]~~ claim 1, wherein the starting control (22) of the generator ~~[the starting of the generator]~~ is controlled ~~[in]~~ such ~~[a manner,]~~ that the starting acceleration of the foot pedal (bmax) on average amounts to a maximum of 4 rad/sect.

5. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein the resistance or load moment (M1) of the generator is modulated in phase with the pedal angle (W1).

6. (Amended) ~~[Drive]~~ The drive system in accordance with ~~[one of the preceding~~

~~claims, characterised in that~~] claim 1, wherein a standstill braking (71) of the foot pedal is active, which produces a standstill pedal resistance TW and which is also effective in case the electric control system (20) is switched off.

7. (Amended) [~~Drive~~] The drive system according to [~~one of the preceding claims, characterised in that~~] claim 1, wherein the generator is short-[~~circuitable~~] circuited by means of an electric switch (33) directly or through resistors, capacitors and coils and wherein the electric switch, in case the electric control system (20) is switched off, is closed for the generation of the pedal resistance TW.

8. (Amended) [~~Drive~~] The drive system in accordance with claim 7, [~~characterised in that~~] wherein, by means of brief switching on and switching off (choppering) of the electric switch (33) during the starting, the high starting moment MA is generated.

9. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that the]~~ claim 1, wherein a range of the maximum efficiency of the generator (6) corresponds to a normal range of the ~~[pedalling frequency, which in preference amounts to 50 - 100 rpm.]~~ pedaling frequency, said normal pedaling frequency range being between about 50 - 100 rpm.

~~[10. Drive system in accordance with one of the preceding claims, characterised in that]~~ 10. (Amended) The drive system according to claim 1, wherein the generator control program (21) comprises several moment characteristics (M60, M120), which are able to be changed over between, and which increase within, a normal range of the ~~[pedalling]~~ pedaling frequency.

11. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein, to the foot pedal (5) and to the generator (6), electrical, mechanical or fluid brakes (45), such as braking resistors, eddy current brakes, friction brake pads, gas - and fluid damping elements or mechanical storage devices (46), such as spring-power storage devices or gas - and liquid storage devices are assigned.

12. (Amended) ~~[Drive]~~ The drive system in accordance with ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein a blockable free-wheel system (42) or a switchable clutch (43) is provided between the foot pedal and the generator.

13. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein the drive system comprises modular units ~~[such as]~~, said modular units being selected from the group consisting of a pedal generator module (8) with foot pedal (5), generator (6), a possible speed transmission (7) and generator control system (20.1), a control module (20) and a drive motor module (18) with motor (11), a possible speed reduction transmission (12) and a motor control system (20.2).

14. (Amended) ~~[Drive]~~ The drive system in accordance with ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein electric storage devices (14), and in particular a super capacitor (15) (super cap), are provided as short-term storage devices.

15. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein two differently designed motors, (11a, 11b) each respectively for higher and a lower speed range, or a motor with switched windings is provided.

16. (Amended) ~~[Drive system in accordance with one of the preceding claims, characterised in that]~~ The drive system according to claim 1, wherein operating data, such moments or torques, powers and revolutions per min on the foot pedal are recorded and indicated.

17. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein an interface (35) is provided for ~~[the connection of]~~ connecting external devices.

18. (Amended) ~~[Drive]~~ The drive system in accordance with ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein a removable data storage device (29) is provided, which when it is removed carries out a closing function of the system.

19. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein the electric circuit comprises operating programs (24), resp., driving riding programs (25) for the ~~[utilisation]~~ utilization in training apparatuses, resp., vehicles.

20. (Amended) ~~[Drive]~~ The drive system in accordance with ~~[one of the preceding claims. characterised in that]~~ claim 1, wherein the electric control ~~[~~ ~~]~~system (20) after a selectable time interval, during which no ~~[travelling]~~ traveling motion takes place, goes over into an inoperative or idle condition and/or the pedal is moved to a desired starting position.

21. (Amended) ~~[Drive]~~ The drive system according to ~~[one of the preceding claims, characterised in that]~~ claim 1, wherein the foot pedal (5)~~[, resp., the muscle-powered drive]~~ comprises a changeable geometry.

22. (Amended) ~~[Vehicle]~~ A vehicle with a drive system in accordance with ~~[one of the claims 1 - 21.]~~ claim 1.

~~[23. Training]~~ 23. (Amended) A training apparatus with a drive system according to ~~[one of the claims 1 - 21.]~~ claim 1.

IN THE ABSTRACT:

The Abstract of the Disclosure has been amended as follows:

~~[Abstract]~~ Abstract of the Disclosure

~~[The]~~ An electric drive system (1) operated by muscle power ~~[comprises]~~ includes a foot pedal (5) and a mechanical generator (6) mechanically connected to ~~[it mechanically,]~~ the foot pedal. The drive system also includes an electric transmission (4) and an electric control system (20) with a control program (21) of the generator, which is able to generate a counter or load moment GM. ~~[In]~~ When used in a vehicle (2), the drive system ~~[comprises]~~ also includes a starting control system (22) for the generator, by means of which a standstill pedal resistance TW and a high starting moment MA is produced at the foot pedal. ~~[Utilised]~~ When used in a stationary training apparatus (3), the drive system ~~[comprises]~~ includes a motor operation control system (23) with a bi-directional converter (31), by means of which the generator is also able to be operated as a motor.

~~[(Figure 1)]~~

5/pats

P29 PCT

DRIVE SYSTEM OPERATED BY MUSCLE-POWER

The invention presented here is related to an electric drive system operated by muscle-power for a vehicle and/or for a stationary training apparatus in accordance with the generic term of claim 1.

From EP 0784008, for example, a drive system of this kind is known in a bicycle with a foot pedal and a generator mechanically connected with the foot pedal system as well as with an electric transmission to a controllable drive motor as electric consumer. These known drive systems with electric transmission, however, have decisive disadvantages. Thus, in particular also the starting, resp., the treading down on the pedal from standstill is not solved, inasmuch as the driver first practically is treading into a void, i.e., the foot pedal when treading down first offers practically no resistance, until the generator has been accelerated to a sufficiently high speed. This absolutely unaccustomed lack of a pedal resistance when starting represents a great risk. It can lead to the consequence, that the rider looses his balance and falls with his bicycle. Over and above, with this also the immediately required adequate starting power cannot be generated with the generator and finally this previous, normal generator characteristic also goes counter to any accustomed riding sensation, which a rider quite naturally expects of a mechanical pedal drive. I.e., the starting characteristic of these electrical drives known up until now in no way corresponds to an ergonomically required characteristic and is also in crass contradiction to the accustomed starting characteristic in the case of mechanical pedal drives.

The known electrical drive systems on the other hand, however, are also not suitable for use in training apparatuses, inasmuch as for the generator an additional effort is required compared with purely mechanically operated training apparatuses, without this already leading to the achievement of essential improvements to the use, resp., to an extension of the applications. A very great disadvantage of previous training apparatuses above all consists in the fact, that with them only a very limited one-sided action is possible, so that the stationary training very rapidly becomes boring and such training apparatuses therefore after initial use are thereupon made use of only rarely or even not at all. It therefore would represent a very important objective, to design training apparatuses to be more attractive, versatile in use and more entertaining, so that they are utilised more and regularly and that with them also a more universal application would be possible.

For this reason, it is the objective of the invention presented here to create an electric drive system, which can be utilised both in vehicles as well as in stationary training apparatuses and that when utilised in vehicles it has a favourable ergonomic starting characteristic, which corresponds to the previous experience and habituation and which in use in training - and in therapeutic apparatuses enables different, more universal operating modes, wherein in particular also eccentric training and pure exercise therapy should be possible.

This objective is achieved by a drive system in accordance with the invention according to claim 1. The dependent claims are concerned with advantageous further developments of the invention, which comprise an especially favourable and ergonomic starting characteristic and with the possibility of universal utilisation for any kind of training as well as

alternative embodiments, which comprise particular advantages with respect to ease of manufacture as well as further applications and types of therapy.

In the following, the invention is explained in more detail in connection with the Figures on the basis of examples. These illustrate:

Fig. 1 A schematic diagram of a drive system in accordance with the invention for vehicles and/or stationary training devices;

Fig. 2 the generator moment in function of the angle of rotation of the pedal when starting;

Fig. 3 the generator moment in function of the pedalling frequency;

Fig. 4 a characteristic over time of the pedalling frequency when starting;

Fig. 5 the generator moment in function of the speed;

Fig. 6 the generator moment in function of the pedalling frequency in the motor operating mode for eccentric training;

Fig. 7 a bicycle with drive modules;

Fig. 8 a multi-track vehicle with rocker drive;

Fig. 9 schematically a drive system with modules;,

Fig. 10 a generator with a short-circuit starting circuit;

Fig. 11 a flat pedal generator module.

Fig. 1 depicts an electric drive system according to the invention 1 for vehicles and/or stationary training apparatus with a foot pedal 5 as a muscle-power driven drive unit and a generator 6 mechanically connected with the foot pedal as well as with an electric transmission 4 from the generator 6 to an electric consumer 10 and/or to a drive motor 11 as well as with an electric control system 20. The electric control system 20 comprises a control program 21 of the generator 6, with which a counter - or load moment GM relative to the forward

pedalling direction v can be generated. Wherein the drive system, utilised in a vehicle 2 (e.g., Fig. 7 and 8), comprises a starting control 22 of the generator 6, with which with an action on the foot pedal 5 from standstill an immediately occurring pedal resistance TW is produced and with which a high starting moment MA is generated at the foot pedal when starting from standstill, until a minimum driving speed Vmin, resp., a normal pedalling frequency f is reached, as is illustrated further with the Figs. 2 to 5. For the use in a stationary training device 3, the drive system 1 as counter - or load moment GM comprises a motor operation control 23 with a bi-directional converter 31, with which the generator 6 can also be operated as a motor, with controlled coupling and uncoupling of electric power, in particular also for eccentric training. This is explained in more detail on the basis of Fig. 6. Fig. 1 further depicts a generator transmission 7 between a foot pedal 5 and generator 6 and a free-wheel system 42 blockable through a program of the control system 20 or a switchable clutch 43. Foot pedal and generator can form a generator module 8 as a separate sub-assembly. For the application in vehicles 2, the motor 11 can have a speed-reducing motor transmission 12 to a drive wheel 19, which can also be designed as a separate sub-assembly, i.e., as motor module 18. As electric consumers 10, a vehicle also comprises an accumulator as an electric storage device 14 and/or a super capacitor 15 for particularly rapid discharge processes in case of a high power requirement of the motor and for rapid charging in case of electric recuperation braking. When used in stationary training apparatus, further electric consumers, e.g., electric brakes, also, however, mechanical brakes 45 and mechanical storage apparatus 46 can serve to dissipate the energy generated at the foot pedal in concentric training operation. Sensors and measurement transducers 37, e.g., on the foot pedal 5, on the generator 6,on the motor 11 and on the drive wheel 19 as well as on further

components of the drive systems are connected with the control system 20 and serve to monitor and control the operation. For this purpose, operating programs 24 for training apparatus as well as driving programs 25 for applications in vehicles are included in the control system 20. An input - and display device 30 serves for the selection of the driving - and operating programs as well as for the display of driving - and operating data, which can be stored in an internal data storage device 29. An interface 35 for the connection to an external apparatus 38, e.g., to a PC, serves for the further controlling, programming and evaluation. A mains power connection 36 can be utilised for the charging of electric storage apparatus 14, 15 as well as, during eccentric training, for operating the generator 6 as a motor.

Depending on the application, it is also possible to connect additional energy sources 48, e.g., a light petrol (gasoline) engine unit as a "range extender", or foldable solar cells.

In the case of previous pedal generator drives with electric transmission, practically no pedal resistance is perceivable in standstill and the resistance or load moment of the generator when starting to pedal is very small, until a sufficient pedalling frequency has been reached, i.e., the rider when starting first of all is treading into a void (curve 70, Fig. 3). On the contrary, however, a user in the case of every mechanical pedal drive operated with muscle-power and especially in the case of a bicycle (with or without electric transmission) expects a standstill treading resistance and a high starting moment or torque from standstill, so that already the first half revolution, i.e., from a pedal position on top to one at the bottom has a high resistance or load moment. This is doubly necessary for normal bicycles with an upright sitting position, so that a user during

starting can support himself on the pedal and so that the pedalling from standstill of the bicycle up to a minimum stable riding speed Vmin of, e.g., 2 m/sec can take place rapidly and with relatively great starting resistance or load and with a perceivable acceleration by pedalling. Otherwise there is the danger, that the rider may slide off the pedals, resp., may fall. A perceivable, sufficiently great starting resistance or load, however, is not only expected and demanded for normal riders (in accordance with 7): Also for reclining bicycle positions, resp., multi-track vehicles (Fig. 8), in the case of which there is no danger of tipping over, when starting from standstill with mechanical muscle-power drives on principle the same characteristic is anticipated, i.e., a sufficiently high starting resistance or load moment MA has to be perceivable. For this reason, in principle with this also the lacking direct coupling of the pedal 5 with the drive wheel 19 (because the bicycle chain has after all been replaced by the electric transmission 4) according to the invention has to be replaced by a reasonable pedal resistance at standstill TW and a high starting moment MA. With this, also the accustomed and anticipated ergonomic riding sensation can be produced. This is further expounded on the basis of the Figures 2 - 5.

Fig. 2 illustrates the characteristic curve of the resistance or load moment M produced by the generator 6 on the tread pedal in function of the angle of rotation of the pedal. Designated as W1 is the pedal starting angle referred to the upper dead centre of the muscle-powered drive as fixed zero point (W1 = 0°) (refer to Figs. 7 and 8). The pedal angle W in contrast refers to the starting with W = 0. Prerequisite is, that starting takes place with sufficient force, resp., moment (torque) and angular acceleration. In accordance with curve M(W), the generator is designed and controlled in such a manner, that

relatively quickly a high pedalling resistance TW and subsequently a high resistance or load moment MA is reached, i.e., e.g., within 0.1 rad, resp., within a few degrees, e.g., 5° - 8°, and that this desired value of the starting moment MA is also not fallen below in the further course of starting, but is increasingly exceeded. In Fig. 2, as an example, a high desired value MA1 of, e.g., 60 Nm for the operation in normal bicycles (according to Fig. 7) and a lower value MA2 of, e.g., 30 Nm for three- or four-wheel vehicles in accordance with Fig. 8 is indicated, in preference the starting moment MA at the pedal amounts to at least 20 - 40 Nm for multi-track vehicles and, e.g., at least 40 - 60 Nm for normal bicycles. Correspondingly also the pedal resistance TW, e.g., can be adjusted to at least 150 - 300 N, resp., 300 - 400 N.

This according to Fig. 3 results in a moment characteristic M(f) (including counter or load moment GM) on the foot pedal 5, which when starting from standstill increases very rapidly, e.g., already at a speed of 10 rpm to the adjusted desired value of the starting moment MA1, resp., MA2 and with which also the desired pedal resistance at standstill TW is present. After starting, in normal riding usually the ride is with a significantly lower average treading moment M, e.g., with 10 - 20 Nm at 60 rpm. In the range of the normal pedalling frequency of, e.g., 50 - 100 rpm, thereupon the generator moment M in preference clearly increases in function of the pedalling frequency f, so that with increasing pedalling frequency an over-proportional increase of power at the generator results. The control program 21 of the generator, resp., the driving programs 25 advantageously can comprise a step changeover, which in principle is similar to a multi-speed mechanical gear transmission. In this, for example, different tightly spaced power stages of 40, 60, 80, 100, 120, 140, 160, 180, 200 W (muscle-power), etc., can be adjustable, referred to a certain normal speed of, e.g.,

70 rpm, corresponding to the characteristic curves M60 ... M120 ... M180 for normal riding. In contrast to a mechanical gear change, these electric steps can be uniformly optimally graded and the electric changeover between the steps takes place without an interruption and evenly. This moment characteristic M(f), depending on the type and the foreseen use of the vehicle as well as in correspondence with the user preferences, can be adjusted, resp., programmed within wide ranges. Thus, i.e., the normal pedalling range, the increase of the moment in the pedalling range, i.e., the characteristic, and the number and ratio of the different power stages can be selected, resp., adjusted. For example, a flat gradient, in the normal case a medium gradient approximately according to curve M180 or also a relatively steep gradient in accordance with curve M180' can be selected. Over and above this, the generator control system is designed in such a manner, that the range of the maximum efficiency of the generator corresponds to the selected range of the pedalling frequency, so that with this during riding practically always the best possible power yield is achieved. The normal pedalling range, as already mentioned, lies between approx. 50 - 100 rpm, for very sporty riders rather higher, e.g., between 70 and 100 rpm, and for normal riders rather lower, e.g., between 50 and 80 rpm.

The curves 70 in contrast illustrate a moment characteristic M of a previous generator drive in Figs. 3 and 6, in function of the angle W, resp., of the pedalling frequency f, as is known, e.g., from EP 0784008. The difference between the two moment curves corresponds to the counter or load moment GM. In the case of these previous drives (without counter or load moment) according to curve 70 the resistance or load moment of the generator at the beginning when starting from standstill is very low and only quite a bit later on, i.e., after starting

reaches sufficiently high values. Ergonomic and safe starting is not possible in this case. This is, because the pedal initially at least with the first treading of the pedal falls through practically without any perceivable resistance, e.g., through an angle W of 1 to 2 rad (60° to 120°), which causes a cyclist to lose his balance, so that he is likely to fall.

Fig. 2 as a further development of the invention also depicts a moment characteristic M1(W1), whereby the resistance or load moment M1 is modulated in phase with the pedal angle W1. In doing so, the resistance or load moment M1, e.g., in the top - and bottom pedal dead centre points with W1 = 0° and 180° is minimal and in between at W1 = 90° and 270° its maximum is reached, i.e., there, where also the equally indicated tangential pedal forces F are at a minimum, resp., maximum. M1 can also be modulated with a phase shift, e.g., with a minimum at W1 = 5° and 185°. This modulation component MM can also be selected, resp., adjusted and MM, e.g., can be equal to 30 - 60% of the maximum value of M1. Also with this modulation of M1, the accustomed riding - and pedalling sensation can be produced. The accustomed uniform cyclic running, as in the case of a purely mechanical foot pedal drive, is on the one hand achieved by the mass inertia of the pedal-generator module 8 and on the other hand by this possible additional modulation M1(W1).

Fig. 4 illustrates the according to the invention ergonomic and safe starting characteristic by means of an illustration of the characteristic in function of time of the pedalling frequency f(t). When starting from standstill (at W = 0, f = 0) with a sufficiently great actuation force F, resp., starting moment M on the pedal 5, the frequency increases uniformly in accordance with curve f1(t), until the normal pedalling frequency after, e.g., 1 - 3 sec, is reached. Essential is, that in doing

so the starting angle acceleration b = Df/Dt is limited. By means of the generator control (20.1, 21), a maximum acceleration bmax of, for example, 3 - 5 rad/sec^2 is predefined or adjusted (for an actuation moment M of, e.g., 50 Nm). In preference this maximum acceleration bmax amounts to, e.g., 4 rad/sec^2 (on average, e.g., over a 90° - revolution of the pedal). In correspondence with the desired application, e.g., a high starting moment MA1 (refer to Figs. 2 and 3) with a very low maximum acceleration of bmax = 3 rad/sec^2 or a low starting moment MA2 corresponding, e.g., to a bmax of 5 rad/sec^2 can be adjusted. A normal pedalling frequency of, e.g., 60 rpm (corresponding to approx. 6 rad/sec) with this would therefore only be reached after approx. 1.2 - 2 sec. After the starting, in normal riding condition, as explained in the context of Fig. 3, in preference a changeover between different riding steps can be made, which, for example, is illustrated in the function f2(t), with a changeover from the characteristic M120 to the characteristic M100, which corresponds to changing down. This electric changeover with a continuing pedalling motion takes place with a constant force and without any interruption or pauses for changeover.

A further illustration of the starting, above all for normal bicycles, is depicted in Fig. 5, where the moment characteristic M(V) is illustrated in function of the speed V. From it, it is also evident, that as from speed 0 at the start, immediately a sufficiently high starting moment MA has to be reached. This not only for reasons of stability and ergonomics, but also, in order to with the generator immediately supply a high starting power corresponding to the high moment M for a rapid acceleration of the vehicle to a minimum stable riding speed Vmin. To achieve this, also battery current can be made use of in support. This in the case of a bicycle amounts to approx. 2 - 3 m/sec. After the start, i.e., in

normal running operation, in most cases one rides with a significantly lower pedal moment M, e.g., with 15 Nm corresponding to a pedalling power of approx. 100 W at 60 rpm. Without this generator control system in accordance with the invention, a bicycle at first in essence would have to be accelerated to the minimum speed Vmin using solely energy from a battery, while the rider first would be treading into a void, as is illustrated by curve 70 in Fig. 3. This ergonomically and from the point of view of energy would run counter to nature and would be absolutely nonsensical. The result would also be a riding sensation so bad and insecure, that quite likely hardly any users and buyers would be able to be found.

The ergonomic starting characteristic described in the context of the Figs. 2 - 5, is of course in the first instance necessary for the application of the drive system in vehicles. In the case of stationary training - and rehabilitation apparatuses, where there is no danger of tipping over for the rider and where no adequate starting acceleration has to be achieved, while this accustomed ergonomic starting characteristic of the muscle-powered drive is desirable, it is, however, not an indispensable necessity. In order for an electric generator drive to make sense there, its fields of application in comparison with known, simple, purely mechanical apparatuses have to be significantly broader and more attractive. This is explained on the basis of Fig. 6, which depicts various possible modes of operation of the generator drive. Here the moment characteristic M(f) in function of the pedalling frequency f is illustrated in both directions (v = forwards pedalling direction with frequency +f and r = backwards or reverse pedalling direction with frequency -f). In this, the generator is in generator operation, i.e., with a resistance or load moment +M (for concentric training in accordance with curves Gv, Gr) as well as in

operation as a motor with moment -M (for eccentric training according to curves Ev, Er).

The curve Gv corresponds to the normal generator drive in vehicles, which, however, can also be utilised on a stationary training apparatus, e.g., with selectable drive programs 25. I.e., a vehicle, e.g., a bicycle, also, however, a light tricycle, can be utilised both as a vehicle as well as also as a stationary training apparatus. Thus when the weather is bad, e.g., a bicycle can be put on a stand in the house and with it any riding programs desired can then be carried out (Fig.7). The generator in principle can also be operated in reverse in accordance with curve Gr (concentric training with backwards pedalling).

According to Fig. 6, the generator drive in principle is designed for 4-quadrant operation (Gv, Gr, Ev, Er), wherein the counter or load moment GM is generated in the quadrants Gv and Er. In the simplest case, the generator, operated as a motor, is utilised for exercise therapy in accordance with the curves Br, Bv in both directions r and v. This only serves to move the limbs (legs, arms or body), essentially without the application of muscle-power, e.g., for a rehabilitation of the ability of movement. The operation of the generator 6 takes place through the bi-directional converter 31, resp., the generator control system 20.1 and the generator control program 21. Starting out from the pure exercise therapy in accordance with curves Br, Bv, the braking muscle-power utilised can be increased at will by means of an adjustable and also programmable moment characteristic -M according to the curves Er and Ev. Therefore any selectable and controllable eccentric programs can be run.

Instead of a pedal crank drive, of course also other types of muscle-power drives can be utilised in an analogue

manner, e.g., linear drives, rowing drives, etc., which are driven by means of leg -, arm - or body movements. Above all for therapeutic applications, in doing so the geometry of the muscle-powered drive can also be designed to be adjustable. In this respect, both the excursion or pedal radius L of the drive movement (L, e.g., corresponds to the radius of a pedal crank, Fig. 1, 11) as well as the position of the user relative to the drive can be adjustable. Thus the movement amplitudes L can be variable for therapy and training (Fig. 11). As a further safety element, e.g., for eccentric training, a characteristic Er, Ev can be controlled in such a manner, that the driving movement of the pedal generator is immediately stopped, in order to prevent injuries, if the user slips off the pedal, resp., if his muscle-powered braking is suddenly interrupted. To achieve this, a suitable sensor 37 is utilised, which detects the change in force.

In the case of eccentric training Er, Ev, relatively high muscle forces and - powers can be utilised with an essentially lower burden on the blood circulation in comparison with concentric training. I.e., to brake the same motor power of the generator requires a much lower effort than to produce it (in principle this corresponds to the experience, that to climb a staircase requires much more effort than to run down it at the same speed). For this reason, the eccentric training (apart from the athletics training) above all in the cardio-vascular therapy provides a very great benefit, resp., opens up new and essentially better possibilities for therapy.

Fig. 7 illustrates a normal bicycle with a drive system 1 comprising modules. On a chassis 53 with a seat 52, a pedal generator module 8 is attached as a sub-assembly, which here comprises a foot pedal 5, a synchronous belt drive 7.1, possibly a blockable free-wheel system 42 and a

generator 6. The electric control system 20 as well as the electric storage devices 14, resp., advantageously also a super capacitor 15 and an input - and display element 30 can also be attached to the chassis as modules or sub-assemblies, which can be separated from it. The electric transmission 4 provides the energy required to a drive motor 11a, which here in the rear wheel 19 is designed, e.g., as a wheel hub motor. In order to achieve optimum efficiencies of the drive motors, e.g., also two differently designed motors 11a and 11b can each respectively be foreseen for a higher and a lower speed range, which is indicated here with a possible additional motor 11b in the front wheel, or else a motor with switched windings can be utilised, which are optimised for differing speed ranges.

A bicycle of this kind can in addition be utilised as a stationary training apparatus in the house, e.g., fixed on a training stand 56. If this stand comprises a braking roller 57, then riding programs can also be carried out with the motor 11a or else an electric consumer 10 can also be directly connected.

Fig. 7 also depicts an additional possible variant, in order to generate a standstill treading resistance TW and for very few revolutions a high starting moment MA. This is in the form of a rewindable cable 41 between the foot pedal 5 and the drive wheel 19. The cable, e.g., can comprise 3 to 5 windings on the foot pedal, resp., 2 - 3 windings on the wheel 19. In contrast to a conventional chain drive, an auxiliary cable 41 of this kind with only one strand, which is reversible and which does not require any lubrication, can also be of a very simple design. When starting, the cable is rewound onto the wheel 19, subsequently for a maximum of 3 revolutions it is wound onto the foot pedal, then uncoupled and rewound once

again. During the next starting, the cable 41 then can be coupled once again.

Fig. 8 illustrates an example of a two-seat multi-track vehicle with two front wheels and one or two rear wheels 19. The drive motor module 18 is designed as a rocker drive 54 with a motor 11, e.g., a synchronous belt or a chain as a speed reducing transmission 12 and if so required with a switchable free-wheel system or with a clutch (43). For a driver 60 and a passenger, a reclining seat each is foreseen, with which the pedal generator modules located far forwards 8.1, 8.2 are both driven by the driver and by the passenger with a flat position of their legs. The zero point of the pedal angle W1 = 0 (i.e., the top dead-centre point), here has a correspondingly flat position, while in the case of the normal bicycle of Fig. 7 it is essentially directed upwards. The modular construction makes it possible to assign an own pedal generator 8.1, 8.2 to every passenger of a multi-seat vehicle and to also remove these if and so required. In an embodiment as a four-wheel vehicle, also two separate motor modules 18.1, 18.2 can be provided for driving the rear wheels 19.

This is shown in the schematic illustration of the modular construction according to Fig. 9. It is possible to utilise one, two or also more pedal generator modules 8.1, 8.2 and equally one or more motor modules 18.1, 18.2, depending on the type - and the application of the vehicle, resp., according to user requirements. This modular concept enables an economical and cost-effective manufacture for a multitude of applications. In doing so, the pedal generator modules 8 and the motor modules 18 can optionally also each comprise the direct generator control system 20.1, resp., motor control system 20.2 (they are, however, components of the overall control system 20).

Above all in vehicles, particularly light and efficient generators 6 and motors 11 are utilised, apart from light carbon brush motors, e.g., also electronically commutating ("brushless") DC - motors and generators. In a light-weight vehicle, which does not require an eccentric operating mode, as a particularly simple and efficient version a single-phase, brushless DC - generator can be utilised, which comprises a correspondingly more simple singe-phase control system with a higher efficiency.

In the case of the application of the drive system 1 in a stationary training apparatus 3, for the purpose of dissipating the generated pedalling energy in concentric training, also electric -, mechanical - or fluid brakes 45, such as brake resistors, eddy current brakes, friction brake pads, gas - and liquid damping elements or mechanical storage devices 46, such as spring-power storage devices or gas - or fluid pressure storage devices can be assigned to the foot pedal 5 and the generator 6. The necessary drive power of the generator in motor operation (in accordance with characteristics Er, Ev in Fig. 6), in the case of eccentric training, can also be acquired through a mains power connection 36. Naturally, alternating with concentric training Gv an electric storage device 14 can be loaded and discharged again with eccentric training Er.

Fig. 10 illustrates a particularly simple example of an embodiment for the generation of a standstill pedal resistance TW and of a sufficiently high starting moment MA on the foot pedal. To do so, the generator 6 is short-circuited directly by means of an electric switch 33 or through resistors R, capacitors C and coils L. The electric switch is closed with the electric control system 20 switched off, so that also then a sufficient pedal resistance TW is present. By a brief switching on and - off ("choppering") of the electric switch 33 during the

start-up from standstill up to an operational pedalling frequency of, e.g., 50 rpm, the high starting moment MA can be produced.

For the generation of a standstill pedal resistance already at a pedalling frequency of f = 0, it is also possible to utilise additional standstill braking 71 (refer to Fig. 3), e.g., in the form of a mechanical brake, which is also effective with the electric control system 20 switched off and which immediately after starting, e.g., already at a pedalling frequency of a few rpm, is released again.

A standstill braking in principle can also be produced by means of a corresponding control of the generator as a motor, which, however, is only effective very briefly, e.g., from W = 0 to 5° (Fig. 2), resp., f = 0 to 3 rpm (Fig. 3).

A preferred optimum angular position of the pedal for starting can, as previously, be achieved by back-pedalling, e.g., by means of a blockable free-wheel system on the generator or by the generator control in the reverse pedalling direction r only producing a small resistance or load moment. As a further variant, the pedal can also be slowly brought to a starting position preferred and programmed by the user, when the system has not been used for some time, and/or the control system after some time can revert to a non-operative (idle) condition.
In a current-saving non-operative (idle) condition, the electronics can also monitor the pedal position.

Normally the system is switched on with a main switch, it is also possible, however, to provide an automatic run-up (autoboot), e.g., by conscious moving of the foot pedal as information to start-up the system, wherein the movement

generates electric power and with this is in a position to switch on the electronics.

Fig. 11 depicts an example of a light, compact, flat pedal generator module 8 with a brushless synchronous motor with permanent magnet on a rotor 61 with a relatively large diameter and a stator 62 on a fixed module housing 63, which also carries the planet wheels of an epicyclic gear 7.2. An external gear wheel 65 is connected with the pedal crank shaft 64. With this single-stage compact transmission, e.g., transmission ratios of 7 - 10 from the pedal 5 to the generator 6 can be achieved with a correspondingly high moment multiplication. I.e., a necessary starting resistance or load moment MA of 50 Nm on the pedal with a 10:1 transmission ratio on the generator only necessitates 5 Nm. If for a particularly simple version of the module 8 no transmission is provided, then the motor should be very flat and designed with a large diameter, in order to be able to achieve greater starting moments MA. A (switchable or blockable) free-wheel system 42 can also be incorporated between the foot pedal 5 and generator 6, e.g., on the external gear wheel 65 or on the rotor 61. As an example of an adjustable geometry, here a possible variable crank length (pedal radius, excursion) L, L' is illustrated.

With the drive system in accordance with the invention 1 in case of a utilisation in vehicles, driving programs 25 of the most diverse kind, for example, with characteristic switching according to Fig. 3, can be incorporated or a parking program for manoeuvring at low speeds up to, for example, 5 km/h (also selectable), where the driving speed of the vehicle is directly electrically proportionally coupled with the pedalling speed, so that one therefore with the pedal movement can manoeuvre forwards and backwards just as well as with a fixed mechanical transmission. As a further important example,

e.g., also a power amplifying driving program can be selected, with which proportional to the muscle-power applied at the foot pedal additional electric power is conducted to the motor from the electric storage device 14. This power amplification factor can also be designed to be selectable, so that, e.g., for overtaking operations or on gradients a higher amplification factor can be set. The factor can also be negative, so that, e.g., only 80 % of the pedal power is made use of for driving and 20 % for charging the batteries. By means of various sensors 37 on the foot pedal, generator, motor and drive wheel, a multitude of data can be recorded, resp., also parameters for the driving programs entered. Sensors and measurement transducers of this type (Fig. 1) can be, e.g., direction sensors, position - and angle of rotation sensors, frequency -, power - and moment sensors, etc. With this, a large number of operating data, such as muscle-power and motor power, speeds, efficiencies, driving resistance or load, energy balance, etc., can be continually recorded and., e.g., stored in an internal storage device 29. The data storage device 29 can also be designed to be removable. For this purpose, e.g., a commercially available electronic pocket diary can be utilised, which not only records conventional tachometer data, such as speed, route length, etc., in function of the driving time, but also pedal power, pedalling frequency and possible heart beat rate. Coupled to a computer, the pocket diary can balance these data, e.g., as a training diary. With a removable data storage device, over and above this a closing function by its removal can be implemented, as well as a switching-on function by the plugging-in of an external data storage device 29. In stationary training, in analogy different operating programs 24 or stationary riding programs can be adjustable and selectable. An external interface 35 serves for the outputting of riding - and operating data to an external device 38, which subsequently, e.g., can be

evaluated and displayed on a PC. Or also an operating program combined with a video game or a video display of a riding route can be played back and ridden or driven.

It is also possible to program driving - / riding routes oneself, and e.g., to optimally ride or drive a defined test route in the application as a training apparatus in accordance with various criteria e.g., as quickly as possible, with an optimum efficiency or with an optimum energy balance (muscle energy, motor energy, storage capacity and riding - / driving performance).

Within the scope of this description, the following designations are used:

1	electric drive system
2	vehicle
3	stationary training apparatus
4	electric transmission
5	foot pedal (muscle-powered drive unit)
6	generator
7	generator transmission
7.1	synchronous belt transmission
7.2	epicyclic gear
8	pedal generator module
10	electric consumer
11	drive motor
11a, 11b	different drive motors
12	motor transmission
14	electric storage device
15	super capacitor
18	motor module
19	wheel, drive wheel
20	electric control system
20.1	generator control system
20.2	motor control system
21	control program for the generator
22	starting control

23	motor operation control for 6
24	operating programs
25	driving - / riding programs
29	data storage device
30	input - and display device
31	bi-directional converter
33	electric switch on 6
35	interface for external connections
36	mains power connection
37	sensors, measurement transducers
38	external device
41	rewindable cable
42	blockable free-wheel system
43	switchable clutch
45	brakes
46	mechanical storage devices
48	additional energy sources
52	seat / saddle
53	chassis
54	rocker drive crank
56	training stand
57	braking roller
60	driver / rider
61	rotor
62	stator
63	housing
64	shaft
65	external gear wheel
70	previous moment - / torque characteristics
71	standstill braking
V, Vmin	speed
f	pedalling frequency of 5
b, bmax	acceleration of f
GM	counter moment, load moment
TW	pedal resistance at standstill
M,M1,Gv, Er, Ev,Br,Bv	moments / torques at 5

MA	starting (resistance) moment on 5
W	starting angle on 5
W1	pedal angle
F	tangential pedal force
L	excursion / leverage, pedal radius
t	time
v, r	forwards, backwards (pedalling direction)

P29

Claims

1. Electric drive system operated with muscle-power (1) for a vehicle (2) and/or a stationary training apparatus (3) with a foot pedal (5) and a generator (6) mechanically connected with the foot pedal, with an electric transmission (4) from the generator (6) to an electric consumer (10) and/or to a drive motor (11) as well as with an electric control system (20), characterised in that the electric control system comprises a control program (21) of the generator (6), with which a counter moment GM on the generator, related to the forwards pedalling direction v is generatable,
   - wherein the drive system as a vehicle drive with counter moment:
     comprises a starting control (22) of the generator, with which when the foot pedal is actuated from standstill an immediately occurring pedal resistance TW is generated
     and with which a high starting moment MA is generated at the foot pedal when starting from standstill up to a minimum riding speed,
   - and wherein the drive system as a drive with counter moment for a stationary training apparatus (3):
     comprises a motor operation control (23) with a bi-directional converter (31), with which the generator (6) is also operatable as a motor, with controllable coupling and uncoupling of electric power.

2. Drive system in accordance with claim 1, characterised in that the standstill pedal resistance TW corresponds to an actuation force F on the foot pedal (5) of at least 200 N.

3. Drive system according to one of the preceding claims, characterised in that the starting moment MA at the foot pedal amounts to at least 40 Nm.

4. Drive system in accordance with one of the preceding claims, characterised in that with the starting control (22) of the generator the starting of the generator is controlled in such a manner, that the starting acceleration of the foot pedal (bmax) on average amounts to a maximum of 4 rad/sec^2.

5. Drive system according to one of the preceding claims, characterised in that the resistance or load moment (M1) of the generator is modulated in phase with the pedal angle (W1).

6. Drive system in accordance with one of the preceding claims, characterised in that a standstill braking (71) of the foot pedal is active, which produces a standstill pedal resistance TW and which is also effective in case the electric control system (20) is switched off.

7. Drive system according to one of the preceding claims, characterised in that the generator is short-circuitable by means of an electric switch (33) directly or through resistors, capacitors and coils and wherein the electric switch in case the electric control system (20) is switched off is closed for the generation of the pedal resistance TW.

8. Drive system in accordance with claim 7, characterised in that by means of brief switching on and switching off (choppering) of the electric switch (33) during the starting the high starting moment MA is generated.

9. Drive system according to one of the preceding claims, characterised in that the range of the maximum efficiency of the generator (6) corresponds to a normal range of the pedalling frequency, which in preference amounts to 50 - 100 rpm.

10. Drive system in accordance with one of the preceding claims, characterised in that the generator control program (21) comprises several moment characteristics (M60, M120), which are able to be changed over between and which increase within a normal range of the pedalling frequency.

11. Drive system according to one of the preceding claims, characterised in that to the foot pedal (5) and to the generator (6) electrical, mechanical or fluid brakes (45), such as braking resistors, eddy current brakes, friction brake pads, gas - and fluid damping elements or mechanical storage devices (46), such as spring-power storage devices or gas - and liquid storage devices are assigned.

12. Drive system in accordance with one of the preceding claims, characterised in that a blockable free-wheel system (42) or a switchable clutch (43) is provided between the foot pedal and the generator.

13. Drive system according to one of the preceding claims, characterised in that the drive system comprises modular units such as a pedal generator module (8) with foot pedal (5), generator (6), a possible speed transmission (7) and generator control system (20.1), a control module (20) and a drive motor module (18) with motor (11), a possible speed

reduction transmission (12) and a motor control system (20.2).

14. Drive system in accordance with one of the preceding claims, characterised in that electric storage devices (14), and in particular a super capacitor (15) (super cap), are provided as short-term storage devices.

15. Drive system according to one of the preceding claims, characterised in that two differently designed motors, (11a, 11b) each respectively for a higher and a lower speed range, or a motor with switched windings is provided.

16. Drive system in accordance with one of the preceding claims, characterised in that operating data, such as moments or torques, powers and revolutions per minute on the foot pedal are recorded and indicated.

17. Drive system according to one of the preceding claims, characterised in that an interface (35) is provided for the connection of external devices.

18. Drive system in accordance with one of the preceding claims, characterised in that a removable data storage device (29) is provided, which when it is removed carries out a closing function of the system.

19. Drive system according to one of the preceding claims, characterised in that the electric circuit comprises operating programs (24), resp., driving or riding programs (25) for the utilisation in training apparatuses, resp., vehicles.

20. Drive system in accordance with one of the preceding claims, characterised in that the electric control

system (20) after a selectable time interval, during which no travelling motion takes place, goes over into an inoperative or idle condition and/or the pedal is moved to a desired starting position.

21. Drive system according to one of the preceding claims, characterised in that the foot pedal (5), resp., the muscle-powered drive comprises a changeable geometry.

22. Vehicle with a drive system in accordance with one of the claims 1 - 21.

23. Training apparatus with a drive system according to one of the claims 1 - 21.

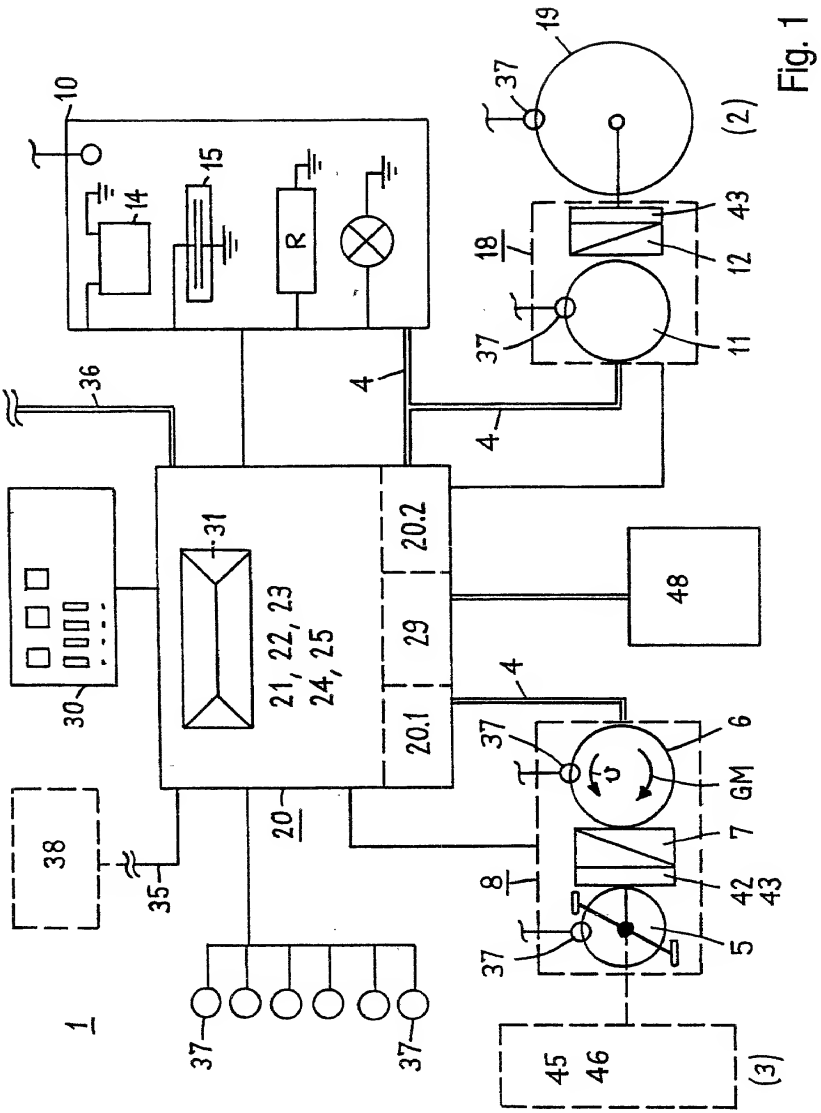

10
14
15
R
19
37
(2)
18
43
12
11
36
4
31
21, 22, 23
24, 25
20.2
29
20.1
48
30
38
35
20
8
7
GM
6
42
43
5
45
46
(3)
1

Fig. 1

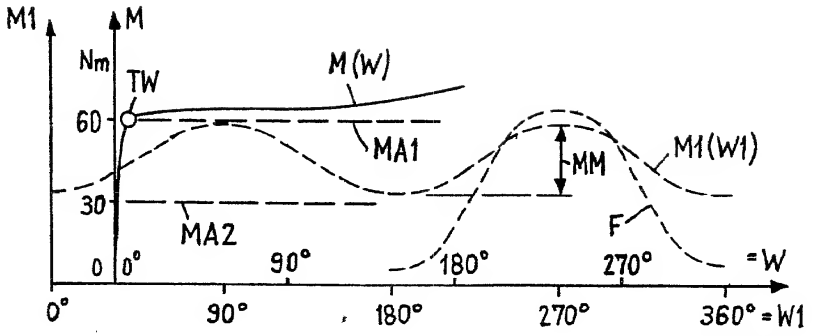


Fig. 2

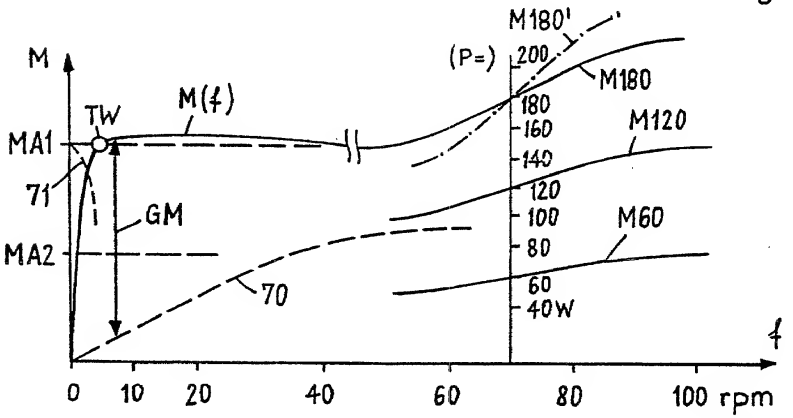


Fig. 3

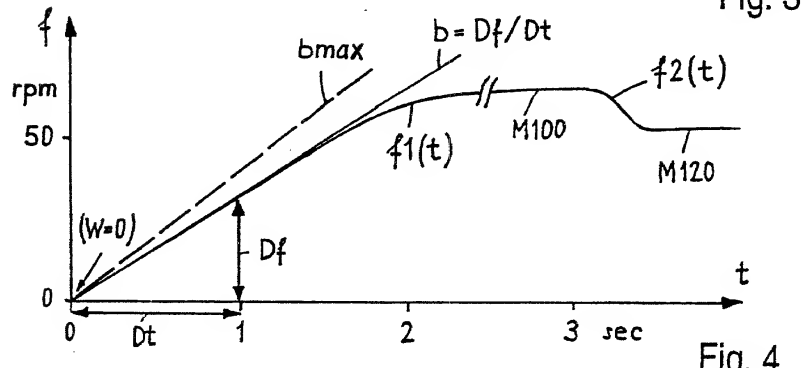


Fig. 4

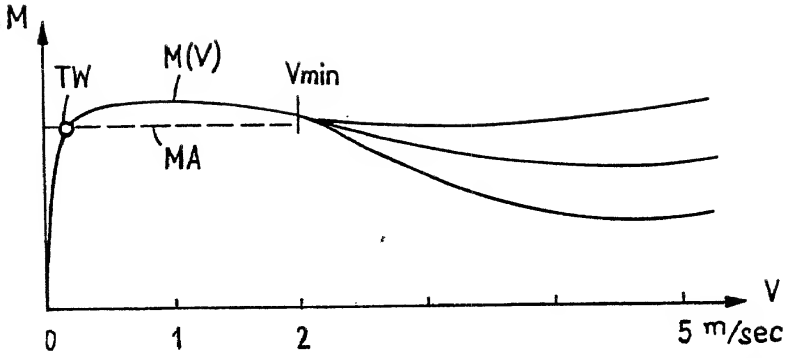

M
TW
M(V)
Vmin
MA
V
0
1
2
5 m/sec

Fig. 5

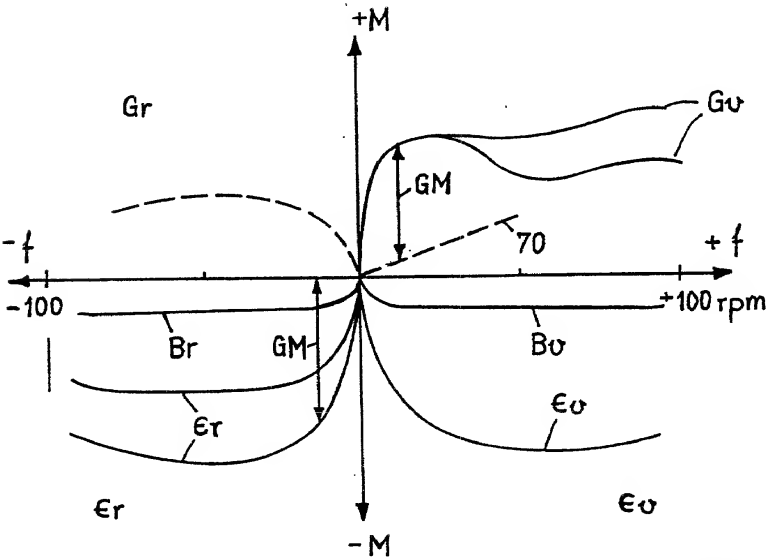
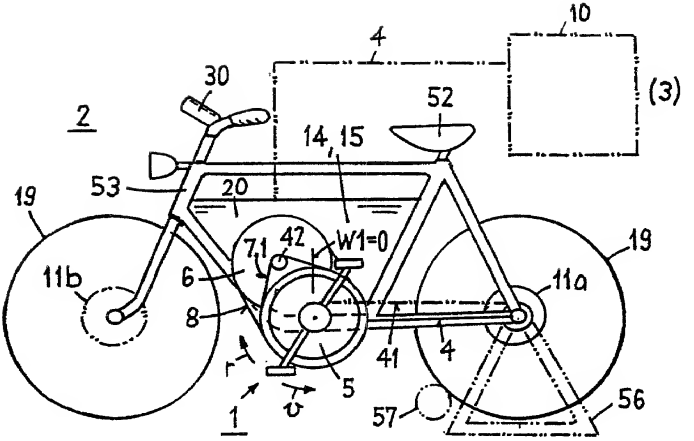

+M
Gr
Gυ
GM
70
-f
+f
-100
+100 rpm
Br
GM
Bυ
εr
ευ
εr
ευ
-M

Fig. 6


10
4
30
(3)
2
52
14, 15
53
20
19
42
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7,1
19
11b
6
11a
8
41
4
r
5
1
v
57
56

Fig. 7

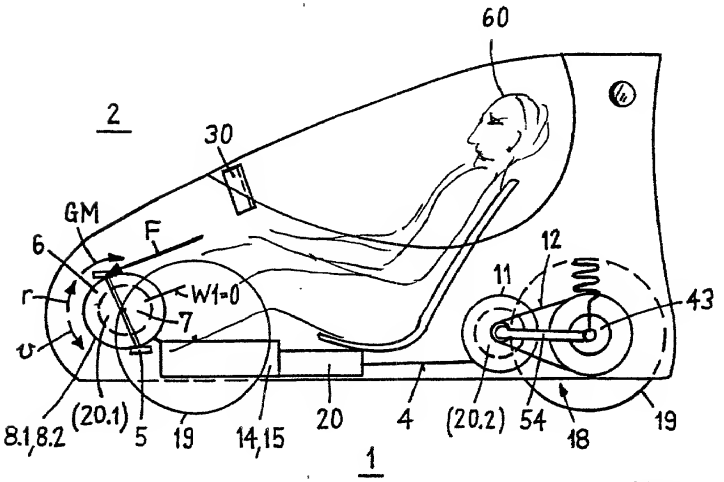
60
2
30
GM
F
6
12
r
W1=0
11
43
7
v
8.1,8.2
(20.1)
5
19
14,15
20
4
(20.2)
54
18
19
1

Fig. 8

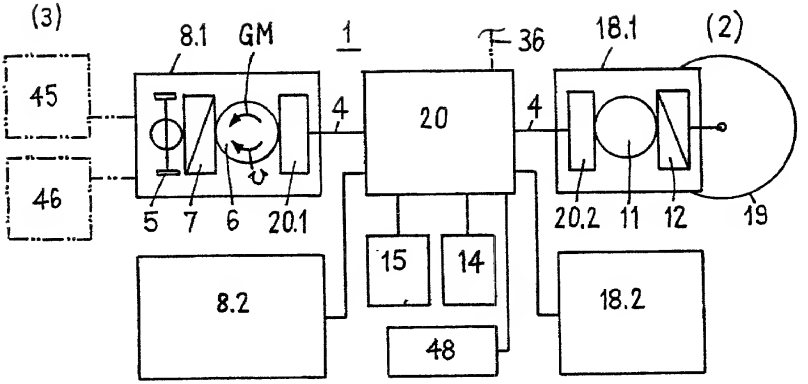

Fig. 9

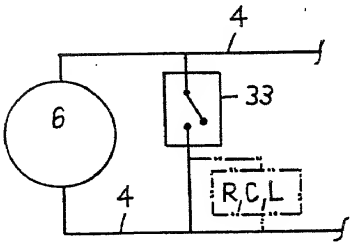

Fig. 10

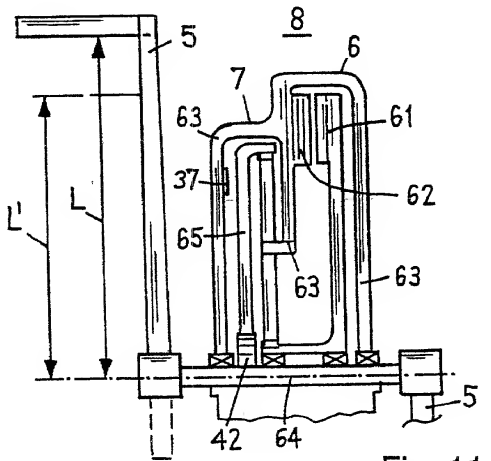

Fig. 11

PTO/SB/01A (10-00)
Approved for use through 10/31/2002 OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. PCT/CH00/00189, filed on March 30, 2000,

☐ as amended on _____(if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

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Signature:		Citizen of:	
Inventor four:		Date:	
Signature:		Citizen of:	

☐ Additional inventors are being named on _____additional form(s) attached hereto.

Application Data Sheet
Application Information

Application Type::	Regular
Subject Matter::	Utility
Suggested classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	None
Number of CD disks::	0
Number of copies of CDs::	0
Sequence submission?::	No
Computer Readable Form (CRF)?::	No
Number of copies of CRF::	0
Title ::	DRIVE SYSTEM OPERATED BY MUSCLE-POWER
Attorney Docket Number::	WLL-12659
Request for Early Publication?::	No
Request for Non-Publication?::	No
Suggested Drawing Figure::	Fig. 1
Total Drawing Sheets::	5
Small Entity?::	Yes
Latin name::	
Variety denomination name::	
Petition included?::	No
Petition Type::	
Licensed US Govt. Agency::	
Contract or Grant Numbers::	
Secrecy Order in Parent Appl.?::	No

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Representative Information

Representative Customer Number::	007609	

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	National State of	PCT/CH00/00189	03/30/00

Foreign Priority Information

Country::	Application number::	Filing Date::	Priority Claimed::
Switzerland	639/99	04/03/99	Yes

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